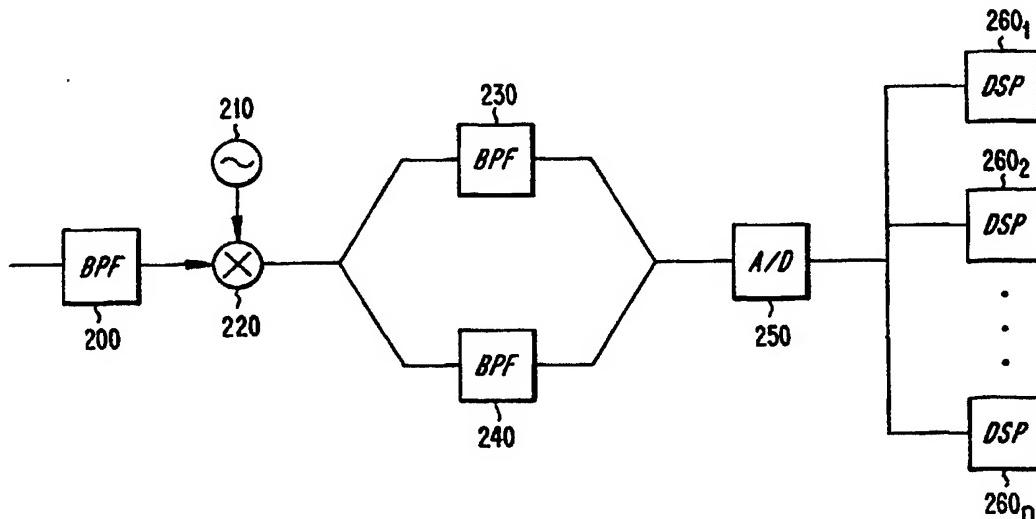




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(54) Title: AMPS A-BAND SINGLE SUPERHET



## (57) Abstract

A wideband receiver is provided for fully covering a desired band with only one mixer and one local oscillator. The wideband receiver advantageously utilizes the inherent aliasing characteristics of the sampling process taking place in the analog-to-digital converter to achieve full coverage of the desired band. More particularly, the wideband receiver is directed to fully covering the A-band of the AMPS frequency plan by analog-to-digital converting two separate parts of a spectrum input to the wideband receiver where said spectrum has a total bandwidth greater than the Nyquist frequency of the analog-to-digital converter without any individual frequency transposition of each spectra part before being input to the analog-to-digital converter. The analog-to-digital converter aliases the transposed desired separate frequency bands to fulfill the Nyquist criteria even when a sampling frequency of the analog-to-digital converter is less than twice the bandwidth of the spectrum. As a result, the wideband receiver minimizes the number of analog parts used so that the wideband receiver is smaller, consumes less power and has a higher manufacturing yield.

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## AMPS A-BAND SINGLE SUPERHET

BACKGROUND

The present invention is directed to a wideband receiver for providing full coverage of a desired band 5 by advantageously utilizing aliasing characteristics of the sampling process. More particularly, the present invention is directed to a device and method for a wideband single superheterodyne (superhet) receiver for full A-band coverage in the Advanced Mobile Phone 10 Service (AMPS) frequency plan with only one mixer and one local oscillator.

Presently, base station receivers for AMPS and D-AMPS are usually designed as double superheterodyne receivers which perform an analog downconversion of each 15 individual narrowband (approximately 30 kHz) channel to a fixed (common for all channels) intermediate frequency. In other words, the same fixed intermediate frequency is used irrespective of which channel the receiver is tuned to. Analog-to-digital conversion of 20 each narrowband channel is then performed and subsequent signal processing is done digitally.

An example of a conventional double superheterodyne receiver system for n channels is illustrated in Figure 1. In Figure 1, desired bands are received by a first 25 bandpass filter 10 which is connected to first pairs of first local oscillators 20<sub>1</sub>, 20<sub>2</sub>, ...20<sub>n</sub> and first mixers 30<sub>1</sub>, 30<sub>2</sub>, ...30<sub>n</sub> so that each received channel is converted to a common fixed intermediate frequency. A plurality of second bandpass filters 40<sub>1</sub>, 40<sub>2</sub>, ...40<sub>n</sub> are 30 connected to the first mixers 30<sub>1</sub>, 30<sub>2</sub>, ...30<sub>n</sub>, respectively for passing through narrowband channels of approximately 30 kHz. The outputs of the second bandpass filters 40<sub>1</sub>, 40<sub>2</sub>, ...40<sub>n</sub> are connected to second pairs of second local oscillators 50<sub>1</sub>, 50<sub>2</sub>, ...50<sub>n</sub> and

second mixers  $60_1, 60_2, \dots 60_n$  for performing an analog down conversion of each individual narrowband channel from the second bandpass filters  $40_1, 40_2, \dots 40_n$ . The outputs of the second mixers  $60_1, 60_2, \dots 60_n$  are  
5 connected to a plurality of third bandpass filters  $70_1, 70_2, \dots 70_n$ . Analog-to-digital converters  $80_1, 80_2, \dots 80_n$  perform analog-to-digital conversion of each narrowband channel and then signal processing is performed  
10 digitally by a plurality of digital signal processors  $90_1, 90_2, \dots 90_n$ .

It is also known to use a wideband receiver in which the whole frequency spectra allocated to the operator is downconverted to a suitable intermediate frequency interval and then converted from analog to  
15 digital. The selection of each narrowband channel and further processing is then done digitally. Figure 2 illustrates an example of this conventional wideband receiver where a signal is input to a first bandpass filter 15 and then downconverted to the intermediate frequency interval by a local oscillator 25 and a mixer 35. The output of the mixer 35 is input to a second bandpass filter 45 and then converted to a digital signal by the analog-to-digital converter 85. The  
20 output of the analog-to-digital converter 85 is input to a plurality of digital signal processors  $95_1, 95_2, \dots 95_n$  for further processing.  
25

In the application of wideband receivers to the AMPS frequency plan, certain difficulties exist which prevent sufficient resolution from being achieved for  
30 the required dynamic range of the wideband receiver. To better illustrate these problems, an overview of the AMPS frequency is provided below in Table 1.

TABLE 1

|   |     |               |                   |
|---|-----|---------------|-------------------|
|   | A'' | 824-825 MHz   | (1 MHz bandwidth) |
|   | A   | 825-835 MHz   | (10 MHz)          |
|   | B   | 835-845 MHz   | (10 MHz)          |
| 5 | A'  | 845-846.5 MHz | (1.5 MHz)         |
|   | B'  | 846.5-849 MHz | (2.5 MHz)         |

As seen in Table 1, the full A- or B-band utilizes 12.5 MHz bandwidth each. Because of the distribution of the bands, a wideband receiver needs to cover 22.5 MHz 10 bandwidth (824-846.5 MHz) for the full A-band and 14 MHz bandwidth for full B-band coverage (835-849 MHz), respectively. Because only the A- and B-bands were originally allocated for mobile telephone use, the later addition of the extended bands A''-, A'- and B'-bands 15 caused the differences in the bandwidth which are necessary for fully covering the A- and B-bands.

To achieve full B-band coverage in a wideband receiver, a sampling frequency of at least 28 MHz ( $2 \times$  20 14 MHz, which is the bandwidth for full B-band coverage) is needed. The 28 MHz sampling frequency is within the limits of the present technology for sufficient resolution to achieve the required dynamic range for the wideband receiver. However, to achieve full A-band coverage, a sampling frequency of more than 45 MHz ( $2 \times$  25 22.5 MHz, the bandwidth for full A-band coverage) is required. This sampling frequency is beyond the present technology for an analog-to-digital converter with sufficient resolution.

In order to overcome this problem of insufficient

resolution, a wideband receiver as illustrated in Figure 3, for example, has been proposed. In the wideband receiver of Figure 3, a first bandpass filter 100 receives the A''-, A'- and A-bands and is connected to a 5 pair of first local oscillator 110 and a first mixer 120 which frequency transpose the A-, A'-, and A''-bands to an intermediate frequency band. The output of the first mixer 120 is connected to second and third bandpass filters 130 and 131 for passing the A- and A''-bands and 10 the A'-band therethrough, respectively. The outputs of the second and third bandpass filters 130 and 131 are connected to pairs of second and third local oscillators 140 and 141 and second and third mixers 150 and 151. The outputs of the second and third mixers 150 and 151 15 are input to fourth and fifth bandpass filters 160 and 161, respectively. The frequency of the second local oscillator 140 and the frequency of the third local oscillator 141 are chosen so that the A''- and A-bands, and the A'-band, respectively, are transposed to a 20 nearly continuous frequency band having a total bandwidth of less than approximately 15 MHz. As a result, the required sampling frequency becomes 30 MHz (2 x the total bandwidth of approximately 15 MHz). The nearly continuous frequency band is input to an analog-to-digital converter 170. The output of the analog-to-digital converter 170 is input to a plurality of digital signal processors 180<sub>1</sub>, 180<sub>2</sub>, ...180<sub>n</sub>. The frequencies of 25 the second and third local oscillators 140 and 141 must be chosen so that a sufficient guardband is provided 30 which prevents the requirements on the anti-aliasing filters from being too stringent.

Figure 4 illustrates another proposed solution which provides a sufficient resolution for the required dynamic range of the wideband receiver. In Figure 4, a 35 first bandpass filter 105 receives the A-, A'-, and A''-

bands and passes these bands through to a pair of a local oscillator 115 and a first mixer 125. The transposed A- and A''-bands are input to a second bandpass filter 135 and the transposed A'-band is input 5 to a third bandpass filter 136. The outputs of the second and third bandpass filters 135 and 136 are input to second and third mixers 155 and 156 which are connected to a common local oscillator 145 so that  $F_{in}$ - $F_{Lo}$  from one mixer and  $F_{Lo}$ - $F_{in}$  from the other mixer are used. The outputs of the second and third mixers 155 10 and 156 are input to fourth and fifth bandpass filters 165 and 166 to provide a nearly continuous frequency band to an analog-to-digital converter 175. The output of the analog-to-digital converter 175 is input to a plurality of digital signal processors 185<sub>1</sub>, 185<sub>2</sub>, 15 ...185<sub>n</sub>. In this wideband receiver, one of the bands is inverted, while the other band is non-inverted, but the inverted band is corrected by the digital signal processors 185<sub>1</sub>, 185<sub>2</sub>, ...185<sub>n</sub>.

20 In both of the wideband receivers proposed in Figures 3 and 4, a double superhet receiver is used with three mixers and at least two local oscillators. The embodiments of the present invention are directed to a wideband single superheterodyne receiver which fully 25 covers a desired band with only one mixer and one local oscillator.

#### SUMMARY

An object of the present invention is to provide a wideband receiver which fully covers a desired bandwidth 30 of frequencies. More particularly, the present invention is directed to a wideband superheterodyne receiver for providing full coverage of the desired band with only one mixer and one local oscillator.

Another object of the present invention is to utilize an analog-to-digital converter which converts two separate parts of a spectrum, where said spectrum has a total bandwidth greater than the Nyquist frequency 5 of the analog-to-digital converter, and to take advantage of the aliasing characteristics during the sampling process in a positive manner so that the wideband receiver provides full coverage of the desired band.

10 A still further object of the present invention is to provide full A-band coverage of the AMPS frequency plan by a wideband receiver having only one mixer and one local oscillator.

15 These objects of the present invention are fulfilled by providing a wideband receiver for full coverage of a desired band comprising a local oscillator operating at a transposing frequency, a mixer connected to said local oscillator for receiving predetermined frequency bands and transposing said predetermined 20 frequency bands to transposed frequency bands in response to said transposing frequency, and an analog-to-digital converter operating at a sampling frequency for aliasing down said transposed frequency bands to achieve full coverage of the desired band. By using the 25 aliasing characteristics of the analog-to-digital converter in a positive manner, the wideband receiver provides full A-band coverage with only one mixer and one local oscillator. Thereby the analog parts of the wideband receiver are minimized so that the wideband 30 receiver is smaller in size, consumes less power and has a high manufacturing yield.

35 The objects of the present invention are also fulfilled by a method for providing full coverage of a desired band with a wideband receiver comprising the steps of operating a local oscillator at a transposing

frequency, receiving predetermined frequency bands with a mixer and transposing said predetermined frequency bands to transposed frequency bands in response to said transposing frequency, and aliasing down said transposed 5 frequency bands by an analog-to-digital converter operating at a sampling frequency to achieve full coverage of the desired band. This method similarly utilizes the inherent aliasing characteristics of this sampling process taking place in the analog-to-digital 10 converter so that full coverage of a desired band is provided with only one mixer and one local oscillator.

Further scope of applicability of the present invention will become apparent from the detail description given hereinafter. However, it should be 15 understood that the detailed description and specific examples, all indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those 20 skilled in the art from this detailed description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are 25 given by way of illustration only, and thus are not limitative of the present invention, wherein:

Figure 1 illustrates a conventional receiver system for n narrowband channels where each channel is processed in a double superheterodyne receiver which 30 converts each narrowband channel;

Figure 2 illustrates a conventional wideband receiver which converts the whole frequency spectra and performs digital processing for n narrowband channels;

Figure 3 illustrates a proposed wideband receiver 35 having three mixers and three local oscillators, making

it possible to convert two separate parts of a spectrum into a nearly continuous frequency band with a bandwidth less than the original spectrum bandwidth;

5 Figure 4 illustrates a proposed wideband receiver having three mixers and two local oscillators, making it possible to convert two separate parts of a spectrum into a nearly continuous frequency band with a bandwidth less than the original spectrum bandwidth;

10 Figure 5 illustrates a wideband receiver for an embodiment of the present invention; and

Figure 6 illustrates an example of a frequency plan for the wideband receiver used in an embodiment of the present invention.

#### DETAILED DESCRIPTION

15 Figure 5 illustrates a wideband receiver for an embodiment of the present invention. In this embodiment, a wideband, single superheterodyne receiver is provided for full coverage of a desired band with only one mixer and one local oscillator. In Figure 5, a  
20 spectrum is input to a first bandpass filter 200 which passes through desired frequency bands. The desired frequency bands passing through the first bandpass filter 200 are input to a mixer 220. The mixer 220 is connected to a local oscillator 210 which operates the  
25 mixer 220 at a transposing frequency. By operating the mixer 220 at the transposing frequency, transposed frequency bands are outputted from the mixer 220. The output of the mixer 220 is input to second and third bandpass filters 230 and 240 for passing the transposed frequency bands therethrough. The transposed frequency bands are input to an analog-to-digital converter 250  
30 which converts the transposed frequency bands to digital signals.

In the sampling process, the analog-to-digital converter 250 operates at a predetermined sampling

frequency which aliases down the transposed frequency bands to inverted and non-inverted frequency bands. The output of the analog-to-digital converter 250 is input to a plurality of digital signal processors 260<sub>1</sub>, 260<sub>2</sub>, 5 ...260<sub>n</sub> for further processing of the frequency bands. The digital signal processors 260<sub>1</sub>, 260<sub>2</sub>, ...260<sub>n</sub> can easily process the inverted frequency band aliased down by the analog-to-digital converter 250. For simplicity, only the parts that are essential for the understanding 10 of the function are shown in the figures and mentioned in the description (the filters, mixers, local oscillators, analog-to-digital converters). However, in the actual implementation of the wideband receiver, various additional circuitry as would be obvious to one 15 of ordinary skill in the art is necessary to ensure that sufficient signal-to-noise ratios are achieved, such as different amplifiers for example.

In the present embodiment, aliasing, which is usually thought of as an undesired property, is used in 20 a positive manner to make it possible to design a wideband receiver for fully covering a desired band in a spectrum with only one mixer and one local oscillator. The analog input spectra consists of two desired parts with bandwidths B<sub>1</sub> and B<sub>2</sub> respectively, separated by a 25 non-desired band with bandwidth G<sub>a</sub>, where  $B_1 + G_a + B_2 > f_{Nyq}$ , and where  $f_{Nyq}$  is the Nyquist frequency of the analog-to-digital converter 250. The aliasing is used to digitally transpose the part with the bandwidth B<sub>2</sub> so that the digital (after analog-to-digital conversion) 30 spectra consists of two desired parts with bandwidths B<sub>1</sub> and B<sub>2</sub> respectively, now separated by a non-desired band with bandwidth G<sub>d</sub>, where  $B_1 + G_d + B_2 < f_{Nyq}$ . By advantageously utilizing the aliasing characteristics of the analog-to-digital converter 250, a sampling 35 frequency can be used that is within the known

limitations for present analog-to-digital converters (approximately 39 MHz). Thereby, even when the sampling frequency is less than twice the bandwidth of the spectrum, the Nyquist criteria is fulfilled by  
5 advantageously utilizing the aliasing characteristics.

When the desired band coverage is for the A-band of the AMPS frequency plan, for example, the wideband single superheterodyne receiver operates as will be described as follows with reference to Figure 6. This  
10 example is used to only illustrate the operation of the wideband receiver for the present embodiment and other considerations must be taken into account when actually designing the wideband receiver, such as sample frequency versus data rate, anti-aliasing filter  
15 structures, etc., which are neglected in this example. The full A-band is input to the first bandpass filter 200 for passing through the A''-, A-, and A'-bands which include the frequencies of 824-835 and 845-846.5 MHz. These frequency bands are then input to the mixer 220  
20 which is operated by the local oscillator 210 at the transposing frequency of 803 MHz and transposes the A''- and A-bands to between the frequencies of  $f_1$  and  $f_2$  (corresponding to 21 and 32 MHz) and the A'-band to between the frequencies of  $f_3$  and  $f_4$  (which corresponds  
25 to 42 and 43.5 MHz) as illustrated in Figure 6. The second bandpass filter 230 passes through the A- and A''-bands between 21 and 32 MHz and the third bandpass filter 240 passes through A'-band frequencies between 42 and 43.5 MHz.

30 With a sampling frequency of  $f_s = 39$  MHz for the analog-to-digital converter 250, the A'-band is aliased down to between 3 and 4.5 MHz (non-inverted) and the A''- and A-bands are aliased down to between 7 and 18 MHz, inverted. Although it is theoretically possible to  
35 use a sampling frequency of approximately 33.5 MHz in

this example, the sampling frequency should be higher, near the 39 MHz used in this example, for practical purposes to provide a sufficient guardband. The theoretical minimum sampling frequency can be calculated  
5 as follows. By placing  $f_s$  between  $f_2$  and  $f_3$  so that  $f_3 - f_s = f_s - f_2 = (f_4 - f_3)$  [Equation 1] the "A'-band of the spectrum is made to alias around  $f_s$  without overlapping the A''- and A-bands. The A''- and A-bands alias around  $f_1$  such that  $f_1 = f_s/2$  [Equation 2]. Thereby, Equation 1  
10 can be rewritten as  $2f_s = f_2 + f_4 = f_2 - f_1 + f_4 - f_1 + 2f_1$  [Equation 3]. Because  $2f_1 = f_s$  according to Equation 2, the relation  $f_s = f_2 - f_1 + f_4 - f_1 = 11 \text{ MHz} + 22.5 \text{ MHz} = 33.5 \text{ MHz}$  for this example. The aliased down A-band is included within the frequencies from 3 to 18 MHz with a  
15 guardband between 4.5 and 7 MHz. The A- and A''-bands are inverted while the A'-band is non-inverted, but the A- and A''-bands are easily processed by the digital signal processors 260<sub>1</sub>, 260<sub>2</sub>, ... 260<sub>n</sub> which receive the output from the analog-to-digital converter 250.

20 By utilizing the inherent aliasing characteristics of the sampling process which takes place in the analog-to-digital converter 250, a wideband superheterodyne receiver is provided for full A-band coverage with only one mixer and one local oscillator. More generally, by  
25 advantageously using the aliasing characteristics, a wideband receiver may be designed for fully covering a desired band with only one mixer and one local oscillator. As a result, the analog parts of the wideband receiver are minimized so that the wideband receiver is smaller, consumes less power, has a higher manufacturing yield and has a reduced manufacturing cost.  
30

35 The invention being thus described, it would be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from

the spirit and scope of the invention, and all such modification as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

CLAIMS:

1. A wideband receiver for providing full coverage of desired separate frequency bands in a spectrum, comprising:
  - 5 a local oscillator operating at a transposing frequency;
  - a mixer connected to said local oscillator for receiving the spectrum and transposing the spectrum to a transposed spectrum in response to said transposing frequency; and
  - 10 an analog-to-digital converter for aliasing said transposed spectrum of the desired separate frequency bands to fulfill the Nyquist criteria when a sampling frequency of said analog-to-digital converter is less than twice the bandwidth of the spectrum.
2. A wideband receiver according to claim 1, further comprising a first bandpass filter for receiving the spectrum having a plurality of frequency bands and passing through the desired separate frequency bands.
- 20 3. A wideband receiver according to claim 1, further comprising a plurality of second bandpass filters for passing through said transposed spectrum.
4. A wideband receiver according to claim 1, wherein the desired separate frequency bands comprise A-, A'- and A''-bands of the full A-band for the AMPS frequency plan.
- 25 5. A wideband receiver according to claim 4, wherein said analog-to-digital converter aliases down said A- and A''-bands together in an inverted manner and aliases down said A'-band in a non-inverted manner.

6. A wideband receiver according to claim 5, further comprising a plurality of digital signal processors for inverting said A- and A''-bands and processing said A-, A'- and A''-bands.

5 7. A wideband receiver according to claim 1, further comprising a plurality of digital signal processors for processing said transposed spectrum after being aliased down by said analog-to-digital converter.

8. A wideband receiver according to claim 1,  
10 wherein the desired separate frequency bands are allocated in the spectrum where said spectrum has a total bandwidth greater than the Nyquist frequency of said analog-to-digital converter and the wideband receiver is a wideband single superheterodyne receiver.

15 9. A wideband receiver comprising:  
a local oscillator operating at a transposing frequency;  
a mixer connected to said local oscillator for transposing a spectrum of first and second bandwidths to  
20 a transposed spectrum of said first and second bandwidths in response to said transposing frequency;  
and

25 an analog to digital converter for aliasing said transposed spectrum of said first and second bandwidths to fulfill the Nyquist criteria when a sampling frequency of said analog-to-digital converter is less than twice the bandwidth of the spectrum.

10. A wideband receiver according to claim 9,  
wherein said first bandwidth comprises A- and A''-bands  
30 and said second bandwidth comprises an A'-band to provide full A-band coverage of the AMPS frequency plan.

11. A wideband receiver according to claim 9,  
further comprising:

a first bandpass filter for passing through said  
spectrum of said first and second bandwidths to said  
5 mixer; and

a second bandpass filter for passing through said  
transposed spectrum of said first and second bandwidths  
from said mixer to said analog-to-digital converter.

12. A wideband receiver according to claim 9,  
10 wherein said analog-to-digital converter aliases down  
said transposed spectrum for said first bandwidth in an  
inverted manner and said transposed spectrum for said  
second bandwidth in a non-inverted manner.

13. A wideband receiver according to claim 9,  
15 further comprising a plurality of digital signal  
processors for inverting said transposed spectrum for  
said first bandwidth and processing said transposed  
spectrum for said first and second bandwidths.

14. A wideband receiver for providing full A-band  
20 coverage of the AMPS frequency plan, comprising:

a local oscillator operating at a transposing  
frequency;

25 a mixer connected to said local oscillator for  
receiving a spectrum of A-, A'- and A''-bands for the A-  
band and transposing said spectrum for said A- and A''-  
bands to a first transposed spectrum and said spectrum  
for said A'-band to a second transposed spectrum; and

30 an analog-to-digital converter for aliasing said  
first and second transposed spectrums for fulfill the  
Nyquist criteria when a sampling frequency of said  
analog-to-digital converter is less than twice the  
bandwidth of said spectrum.

15. A wideband receiver according to claim 14, wherein said analog-to-digital converter aliases down said first transposed spectrum to an inverted spectrum and said second transposed spectrum to a non-inverted 5 spectrum.

16. A wideband receiver according to claim 14, further comprising:

a first bandpass filter for passing through said spectrum of said A-, A'- and A''-bands to said mixer;

10 a second bandpass filter for passing through said first transposed spectrum from said mixer to said analog-to-digital converter; and

15 a third bandpass filter for passing through said second transposed spectrum from said mixer to said analog-to-digital converter.

17. A method for providing full coverage of desired separate frequency bands in a spectrum by a wideband receiver, comprising the steps of:

20 (a) operating a local oscillator at a transposing frequency;

(b) receiving the spectrum and transposing the spectrum to a transposed spectrum in response to said transposing frequency by a mixer; and

25 (c) aliasing said transposed spectrum of the desired separate frequency bands by an analog-to-digital converter to fulfill the Nyquist criteria when a sampling frequency of said analog-to-digital converter is less than twice the bandwidth of the spectrum.

18. A method according to claim 17, further 30 comprising the steps of:

(d) receiving the spectrum having a plurality of frequency bands by a first bandpass filter and passing

through the desired separate frequency bands to said mixer; and

(e) receiving said spectrum from said mixer by a second bandpass filter and passing through the desired  
5 separate frequency bands to said analog-to-digital converter.

19. A method according to claim 17, wherein the spectrum comprises a first frequency band for A- and A''-bands and a second frequency band for an A'-band of  
10 the full A-band for the AMPS frequency plan.

20. A method according to claim 19, wherein said step (c) aliases down said first frequency band in an inverted manner and said second frequency band in a non-inverted manner.

15 21. A method according to claim 20, further comprising the steps of inverting said first frequency band and processing said first and second frequency bands by a plurality of digital signal processors.

20 22. A method for providing full coverage of desired separate frequency bands in a spectrum by a wideband receiver comprising the steps of:

(a) operating a local oscillator at a transposing frequency;

25 (b) receiving the spectrum of first and second bandwidths and transposing the spectrum of said first and second bandwidths to a transposed spectrum of said first and second bandwidths in response to said transposing frequency;

30 (c) aliasing said transposed spectrum of said first and second bandwidths by an analog-to-digital converter to fulfil the Nyquist criteria when a sampling frequency

of said analog-to-digital converter is less than twice the bandwidth of the spectrum.

23. A method according to claim 22, wherein said first bandwidth comprises A- and A''-bands and said 5 second bandwidth comprises an A' band to provide full A-band coverage of the AMPS frequency plan.

24. A method according to claim 22, further comprising the steps of:

(d) receiving the spectrum of said first and second 10 bandwidths and passing through said first and second bandwidths to said mixer; and

(e) receiving said transposed spectrum of said first and second bandwidths from said mixer and passing through said transposed spectrum of said first and 15 second bandwidths from said mixer to said analog-to-digital converter.

25. A method according to claim 22, wherein said step (c) aliases down said transposed spectrum for said first bandwidth in an inverted manner and aliases down 20 said transposed spectrum for said second bandwidth in a non-inverted manner.

26. A method according to claim 22, further comprising the steps of inverting said transposed spectrum for said first bandwidth and processing said 25 transposed spectrum for said first and second bandwidths by a plurality of digital signal processors.

27. A method for providing full A-band coverage of the AMPS frequency plan by a wideband receiver comprising the steps of:

30 (a) operating a local oscillator at a transposing

frequency;

5 (b) receiving a spectrum of A-, A'- and A''-bands of the A-band with a mixer and transposing said spectrum for said A- and A''-bands to a first transposed spectrum and said spectrum for said A'-band to a second transposed spectrum; and

10 (c) aliasing said first and second transposed spectrums to fulfill the Nyquist criteria when a sampling frequency of said analog-to-digital converter is less than twice the bandwidth of said spectrum.

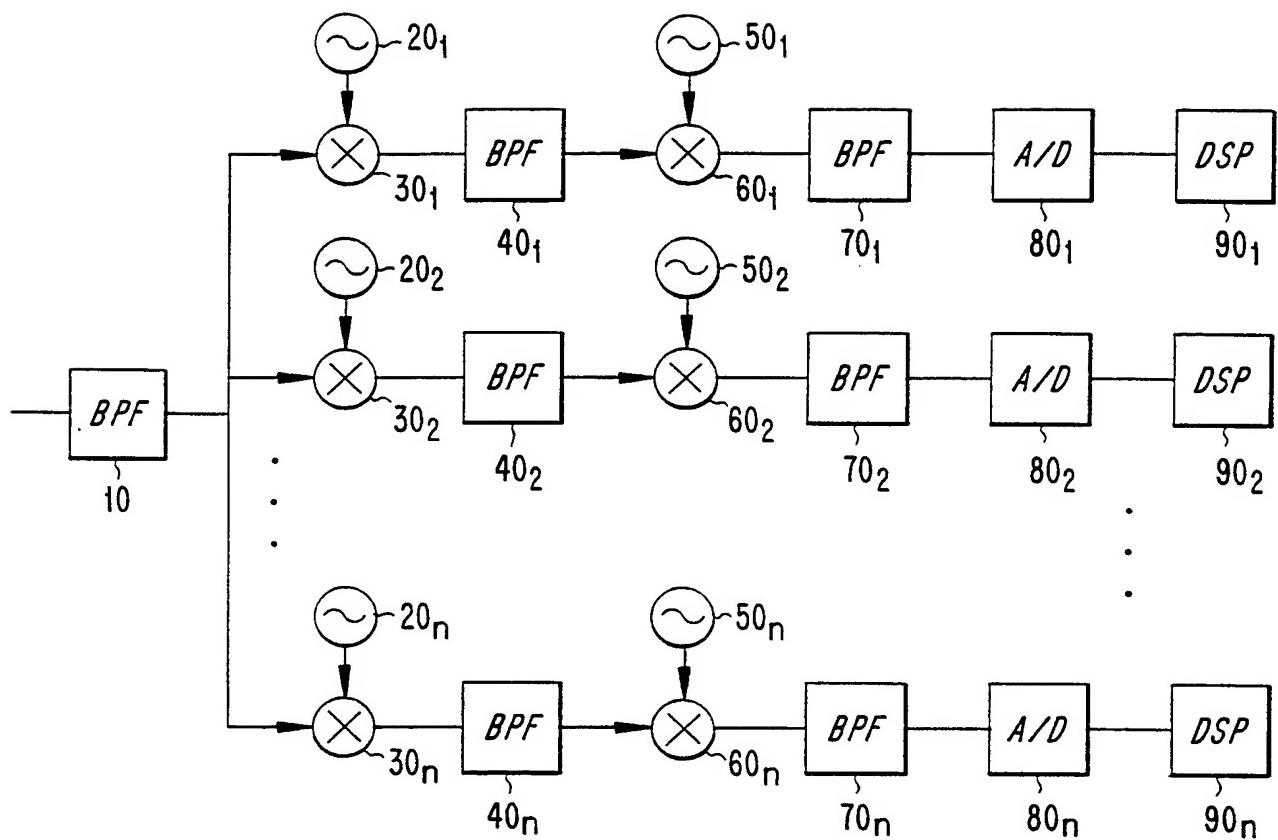
28. A method according to claim 27, wherein said step (c) aliases down said first transposed spectrum to an inverted spectrum and said second transposed spectrum to a non-inverted spectrum.

15 29. A method according to claim 27, further comprising the steps of:

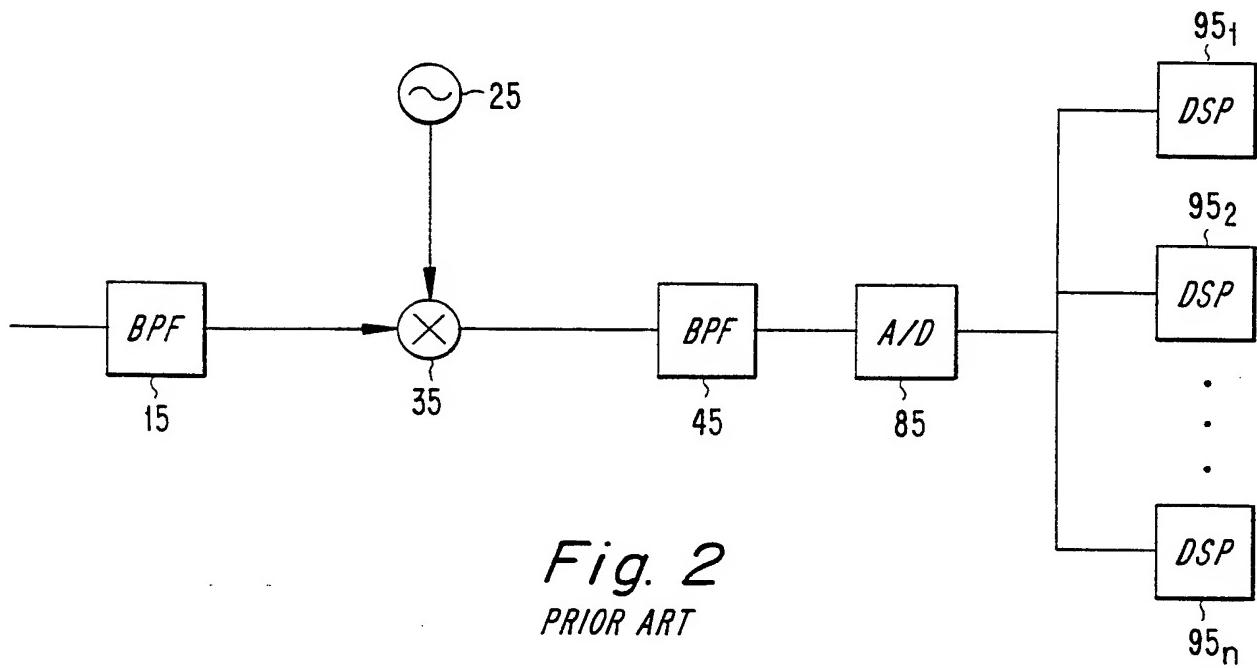
20 (d) receiving said spectrum of said A-, A'- and A''-bands by a first bandpass filter and passing through said spectrum of said A-, A'- and A''-bands to said mixer;

(e) receiving said spectrum of said A- and A''-bands from said mixer by a second bandpass filter and passing through said first transposed spectrum to said analog-to-digital converter; and

25 (f) receiving said spectrum of said A'-band from said mixer by a third bandpass filter and passing through said second transposed spectrum to said analog-to-digital converter.



*Fig. 1*  
PRIOR ART



*Fig. 2*  
PRIOR ART

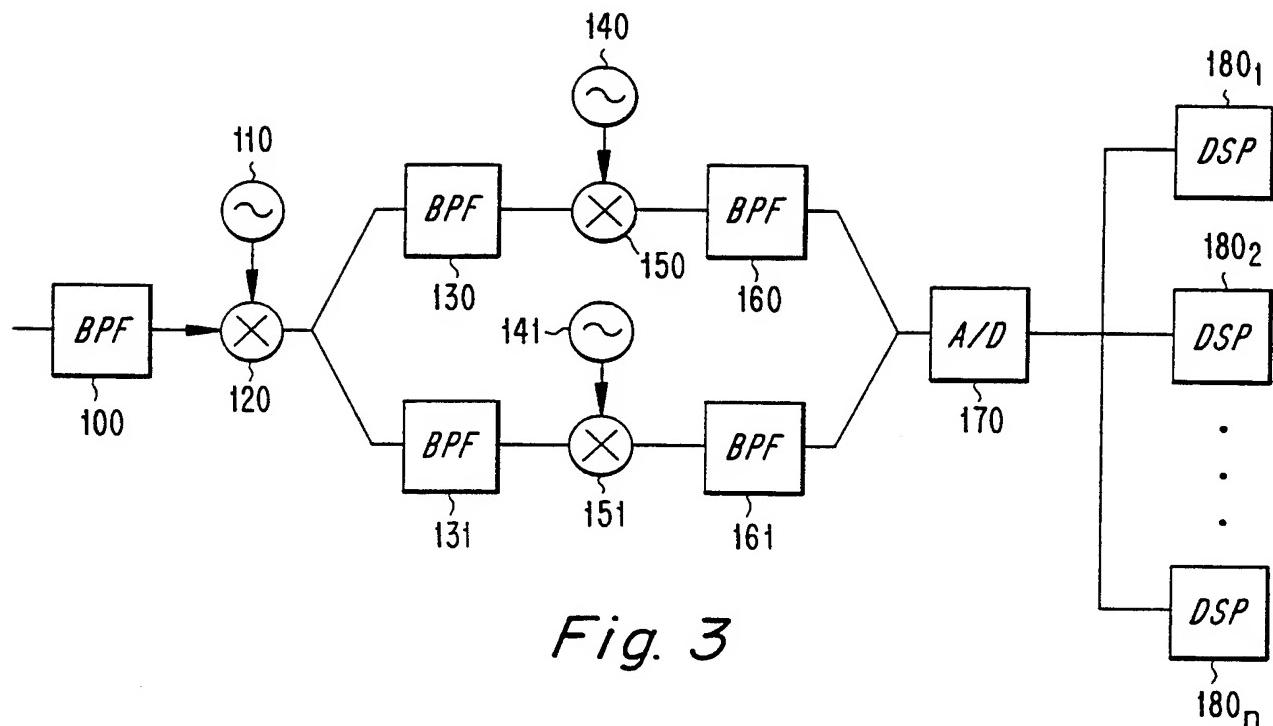


Fig. 3

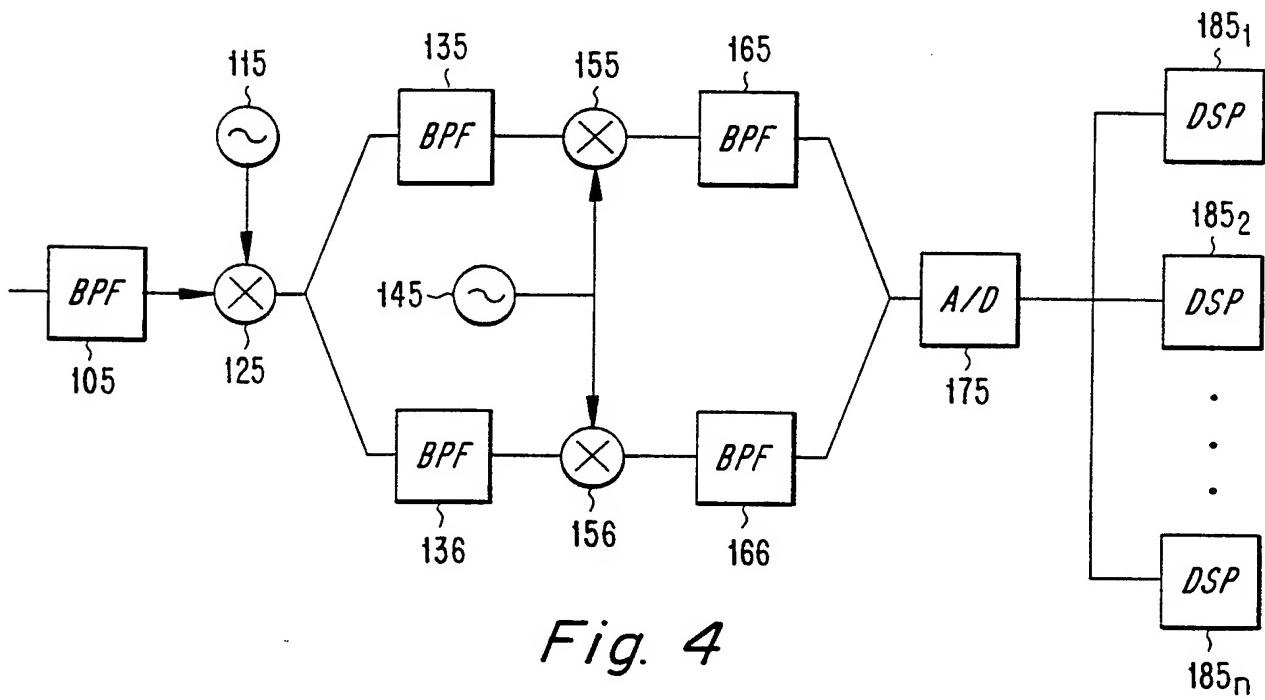


Fig. 4

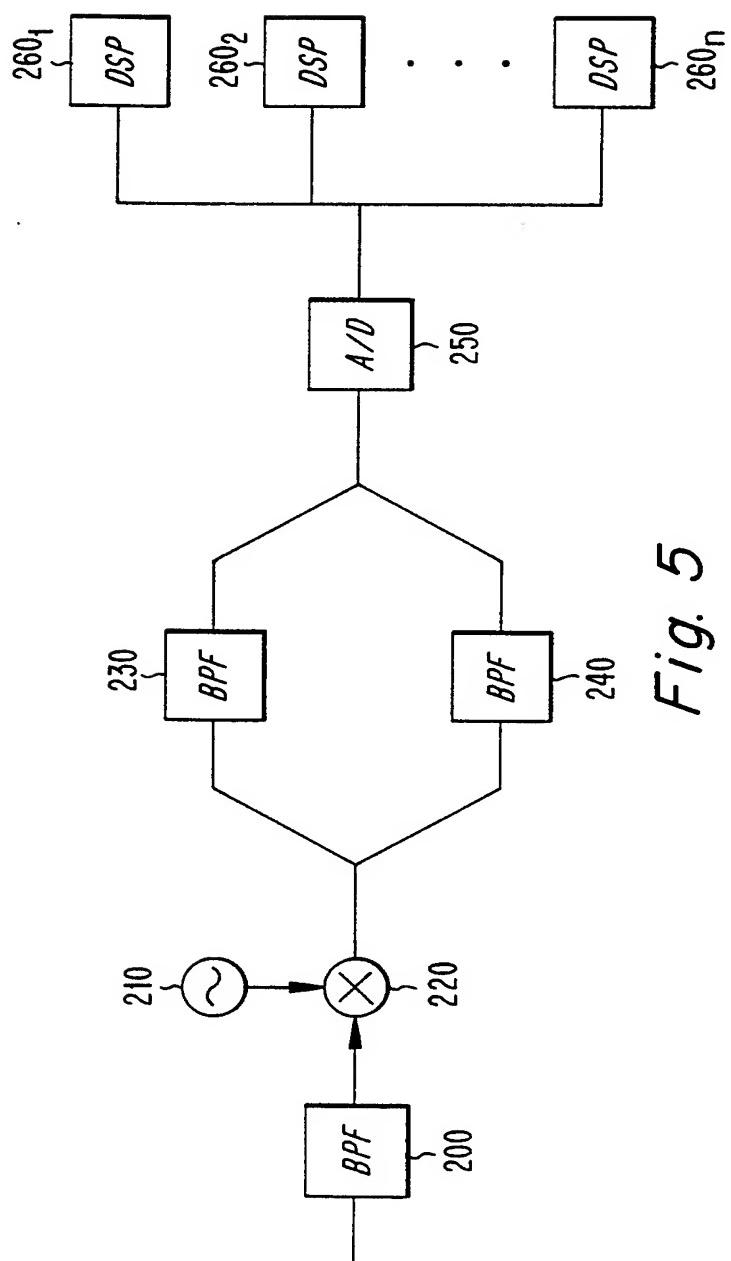


Fig. 5

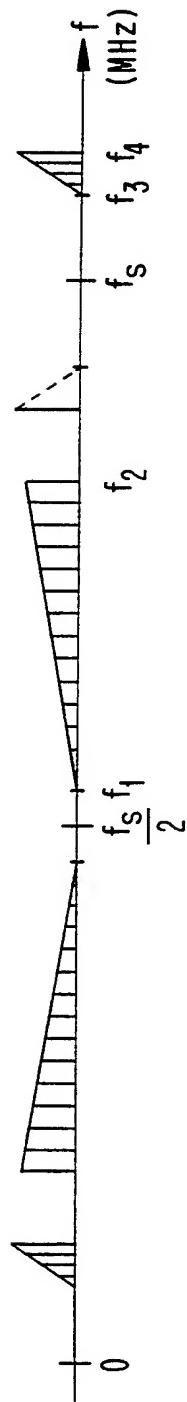


Fig. 6

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/SE 96/00961

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 H04B1/26

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.  |
|----------|---|--|
| A        | US,A,5 289 464 (WANG) 22 February 1994<br>see column 2, line 30 - column 3, line 44;<br>figure 1<br>---<br>A US,A,5 436 955 (KAEWELL JR. ET AL) 25 July<br>1995<br>see column 1, line 7 - line 54<br>---<br>A ELECTRONICS ENGINEERING,<br>vol. 63, no. 771, March 1991,<br>WOOLWICH, LONDON, GB,<br>pages 31-38, XP000223926<br>OLMSTEAD: "The GSM cellular telephone<br>system and its components"<br>see page 36, column 2, line 6 - page 38,<br>column 2, line 8; figures 2,3<br>----- | 1,9,14,<br>17,22,27<br><br>4,10,14,<br>19,23,27<br><br>1,9,14,<br>17,22,27 |

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

## \* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

24 October 1996

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/JP 96/00961

| Patent document cited in search report | Publication date | Patent family member(s) |         | Publication date |
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|  |                  | EP-A-                   | 0589594 | 30-03-94         |
|  |                  | JP-A-                   | 6204958 | 22-07-94         |
| US-A-5436955                           | 25-07-95         | NONE                    |         |                  |